

Atty. Docket No. OPP031475US  
Serial No: 10/748,652

Remarks

Applicant and his representatives wish to thank Examiner for the thorough examination of the present application, the detailed explanations in the Office Action dated November 22, 2005, and the indication that the subject matter of Claims 4-8 is allowable. Claim 1 has been amended to include the limitations of the original Claim 6, and Claim 6 has been cancelled. Support for new Claim 9 may be found in paragraph [0017] of the original specification of the present application.

The present invention relates to a method for forming a trench in a semiconductor device. The method (as set forth in amended Claim 1 above) generally includes the steps of (a) forming a pad oxide film and a silicon nitride film on a semiconductor substrate, (b) selectively etching the silicon nitride film and the pad oxide film on a region to be formed with a trench, (c) implanting oxygen ions into the semiconductor substrate in the region to be formed with the trench, (d) forming an oxide in the semiconductor substrate by reacting the oxygen ions with the semiconductor substrate through a thermal diffusion of the oxygen ions, (e) forming the trench by etching the semiconductor substrate and the oxide on the region to be formed with the trench using the silicon nitride film as a mask, (f) forming a liner oxide film on an inner wall of the trench using a thermal diffusion process, and (g) forming an insulation film on the liner oxide film such that the trench is filled, wherein an edge at which a side and a bottom of the trench intersect has a curved surface.

The references cited against the originally-filed Claims (Kim, U.S. Pat. No. 6,008,526 [hereinafter "Kim"], and Kao et al., U.S. Patent Application No. 20030170964 A1 [hereinafter "Kao"]) neither disclose nor suggest implanting oxygen ions and forming an oxide in the region of the trench to be formed *prior to* forming the trench. Consequently, the present claims are patentable over the cited references.

Atty. Docket No. OPP031475US  
Serial No: 10/748,652

The Rejection of Claims 1-3 under 35 U.S.C. § 103(a)

The rejection of Claims 1-3 under 35 U.S.C. § 103(a) as being unpatentable over Kim in view of Kao has is respectfully traversed.

As recited in independent Claim 1, the trench is formed after implanting oxygen ions and forming an oxide. The oxygen ions are implanted in the region "*to be formed with the trench.*" That is, the oxygen ions are implanted prior to the formation of the trench, in the location where the trench *will be* formed (see Claim 1, lines 6-7 of the present amendment; see also, e.g., ion implantation region 15 of FIG. 2b, and paragraph [0015] of the specification of the present application). The oxide is then formed by reacting the oxygen ions (see Claim 1, lines 8-9 of the present amendment; see also, e.g., silicon oxide region 16 of FIG. 2c, and paragraph [0016] of the specification of the present application). Finally, the trench is formed "*by etching the semiconductor substrate and the oxide...*" (see Claim 1, line 10 of the present amendment; see also, e.g., trench 100 of FIG. 2d, and paragraph [0017] of the specification of the present application). Therefore, it is clear from the language of Claim 1 that the oxygen ions are implanted, and the oxide is formed, *prior to* forming the trench. The present application discloses that this sequence of steps provides the advantageous result that an edge at the intersection of the side and bottom of the trench has a curved surface, due to the different etching rates of silicon oxide 16 and silicon substrate 11 (see, e.g., paragraph [0017]).

Kim relates to a method of forming a trench in a semiconductor substrate wherein the trench is formed first and an oxide is then formed within the trench (see, e.g., Kim, col. 6, lines 18-21). Kim fails to teach or suggest a method of forming a trench wherein the oxide is formed in the trench location *prior* to forming the trench. Furthermore, Kim does not teach or suggest that reversing this sequence of steps can provide the advantageous result that an edge at the intersection of the side and bottom of the trench can have a curved surface.

Kao also relates to a method of forming a trench in a semiconductor substrate wherein the trench is formed first and an oxide is then formed within the trench (see, e.g., Kim, FIGS. 4 and 11, and paragraphs [0079] and [0080]). Thus, Kao fails to cure Kim's deficiencies with respect to forming a trench wherein the oxide is formed in the trench location *prior* to forming the trench.

Atty. Docket No. OPP031475US  
Serial No: 10/748,652

Therefore, independent Claim 1 and dependent Claims 2 and 3 are patentable over Kim in view of Kao, and the rejection should be withdrawn.

Conclusions

In view of the above amendments and remarks, all bases for objection and rejection are believed to be overcome, and the application is believed to be in condition for allowance. Early notice to that effect is earnestly requested.

If it is deemed helpful or beneficial to the efficient prosecution of the present application, the Examiner is invited to contact Applicant's undersigned representative by telephone.

Respectfully submitted,



Andrew D. Fortney, Ph.D.  
Reg. No. 34,600

Alec B. Plumb  
Reg. No. 56,433  
THE LAW OFFICES OF ANDREW D. FORTNEY, PH.D., P.C.

7257 N. Maple Avenue, Suite 107  
Fresno, California 93720  
(559) 299 - 0128